Increased market penetration of solar thermal technologies for low/medium grade heating applications in India

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Haryana Renewable Energy Development Agency
SCO No.48
Sector 26, Chandigarh

Tel: 0172-740966/791917
Fax: 0172-790928

Project Brief

Project title	Increased market penetration of solar thermal technologies for low/medium grade heating applications in India
Requesting Country	India3
Project type	Full Project
Duration	6 years
GEF Implementing Agency	UNDP
Executing Agency	Ministry of Non conventional Energy Sources
Local Implementing Agency	HAREDA, PEDA, REDA with support from TERI
Eligibility	India ratified the UNFCC on November 1993
GEF Focal Area	Climate Change
GEF Operational Programme	Operation Programme 6

Summary

The demand for energy in the country has been growing rapidly and India continues to be a large-scale importer of energy. A significant portion of this energy is consumed for meeting thermal energy requirements, e.g. water heating and process heating, in industrial, commercial, and domestic sectors. Looking at these applications and considering the fact that India has abundant solar radiation, there exists a vast potential for the utilization of solar thermal systems. But the fact remains that the full potential of solar thermal applications has not been realized as yet. The main constraints are high up-front costs and inadequacies in crucial aspects, such as after-sales service; operation and maintenance; technical consultancy for system design and integration etc. Thus, for addressing aforementioned barriers in a cost effective and efficient manner, thereby accelerating the growth and penetration of solar thermal systems, it is proposed to try out an innovative approach that is based on energy service companies supplying solar thermal energy to the users. These solar energy service companies (SESCos) would act as single point source for a variety of activities concerned with users' needs. The project will provide support for formation and sustainable operation of SESCos by way of providing low interest loan, contingency fund to cover the risk. Besides, the proposed project also endeavours to build up technical capability as well as raise awareness levels.

Project cost and financing

	Million US $	Per cent
Total project cost	34.09	100
GEF Financing	8.24	24.2
Co- Financing		
MNES	3.06	9
SNAs	0.08	0.2
Users	22.71	66.6

MNES: Ministry of Non-Conventional Energy Sources

SNAs: State Nodal agencies

Expected CO_2 savings 0.9 million tons

List of acronyms and abbreviations

BIS	Bureau of Indian Standards
GEF	Global Environment Facility
GHG	Green House Gas
HAREDA	Haryana State Energy Development Agency
HSD	High Speed Diesel
IREDA	Indian Renewable Energy Development Agency Limited
MNES	Ministry of Non-conventional Energy Sources
PEDA	Punjab Energy Development Agency
PM	Project Manager
R&D	Research and Development
REDA	Rajasthan Energy Development Agency
SEC	Solar Energy Centre
SESCo	Solar Energy Services Company
SNA	State Nodal Agencies
SSI	Small Scale industry
TERI	Tata Energy Research Institute
UNDP	United Nations Development Programme

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1. Background and context

1.1 The energy sector in India

The demand for energy in the country has been growing rapidly, and India continues to be a large-scale importer of energy. While India has substantial proven coal reserves at 70 billion tonnes, it has very limited known reserves of oil and natural gas, which may last only 16 and 23 years respectively. Projections for crude imports indicate that import dependence, which is 66% at present, will rise to 80% by 2010. The Planning Commission has projected import of 210 million tons of coal and 155 million tons of oil by 2011-12 in BAU (business as usual) scenario. Moreover, to bridge India's peak power shortages of 13%–15% and average shortages of 8%–10% in the BAU scenario, nearly 100,000 MW of fresh capacity addition would be required by 2012. India, the world's second most populous nation, has seen its population grow from 300 million in 1947 to approximately one billion today. This rapidly growing population, along with increased economic development, has placed a strain on India's infrastructure, and ultimately on the environment. Environmental conditions, in terms of a degradation of the natural resource base and increasing industrial pollution, continue to worsen. Obviously, energy supply options to meet the demand in the business as usual approach are not only capital intensive, but environmentally unsustainable as well.

Thermal energy in industrial, commercial and domestic sectors constitutes one of the major portions of overall energy demand in the country. These thermal requirements are presently met either through combustion of fossil fuels like coal, lignite, diesel, and fuel oil, or through electricity. There are 22 major industrial sectors where boilers supply process heat up to a temperature of 150°C. These include dairy, food processing, textiles, hotels, edible oil, chemical, marine chemicals, bulk drug, breweries, and distilleries. Besides, in the commercial sector, e.g. in hotels, guest houses, and hospitals, a large portion of thermal energy is required in the temperature range of 40 °C –80°C. The water-heating requirement in the domestic sector also falls in the same range. The solar thermal technologies are most appropriate in this temperature range and hence can be very effectively used to meet this thermal energy demand.

1.2 Solar thermal technology in India

Solar resource

India is endowed with a very good solar energy resource. The radiation availability is of the order of 5 kWh/m², with 280 -300 clear days in the north-west region of the country, where the states of Haryana, Rajasthan, and Punja (states in which the proposed project will be implemented) are situated.

Status of solar thermal technology in India

As a result of the solar thermal programme undertaken by the Government of India along with several state governments, the solar water heating systems (based on solar flat plate collectors) have reached 'near commercialization' sta in India. The fact that the total installed collector area in India has reached 0.5 million m² in the year 2000, (annual installation in the year 2000-01 being 50,000 m²), establishes the techno-economic viability of solar water heating systems. The National Renewable Energy Policy (draft) has set a goal of installing 5 million m² collector area during 2000-2012, with equal distributio of collector area in the domestic as well as the commercial and industrial sectors.

Presently, the promotional efforts in the solar thermal sector are limited to the provision of low interest loans by IREDA (Indian Renewable Energy Development Agency) and fiscal incentive in the form of accelerated depreciation. However, the benefit of accelerated depreciation is not available the individuals, i.e. for domestic users. The interest rates offered are 5% for domestic systems and 8.5% for commercial and industrial systems.

The current policy environment has been successful in creating a broad manufacturing base and human capacity. There are 52 manufacturers of solar thermal systems in India that produce flat plate collectors with the BIS certification. This capacity, however, is not utilized fully so far, for want of market.

In the North West region, in spite of very high resource availability, the penetration of solar thermal systems is low compared to other regions in India

Potential of solar thermal systems

As per MNES estimations, while the technical potential of solar thermal syste (in terms of collector area) is 140 million m², the realizable market potential is about 30 million m². The potential market can be categorized into the followin two segments:

- Industrial and commercial, which includes industries, hotels, hospitals, hostels etc.
- Domestic.

In case of commercial (e.g. hotels and hospitals) and domestic sectors, the solar thermal systems are directly used to meet hot water requirements. But in the industrial sector, the solar water heating systems could be used either directly to meet process heating requirements or for preheating (in case the energy is required at temperatures above 80 °C). Earlier studies have shown that there are 22 industrial sectors where solar thermal systems could be successfully used. Out of these, sectors such as textiles, dairy, food processing, chemical, breweries, and distilleries textile could be focussed initially.

There are 722 large and medium scale industries in Haryana, which is one of the focal state. From the survey in industrial sector of Haryana, 22-24% of the industries need 2000 to 20000 litres of hot water in the process. Thus the potential for solar thermal systems in large and medium industries in Haryana is approximately equivalent to 33,000m^2 of solar collector area. The possible annual fuel saving is 2100 tons of oil equivalent.

In view of the rapidly increasing conventional fuel prices, the Indian industry is desperately searching for alternatives. Several small and medium-scale industries would be highly receptive at present towards the idea of using solar thermal energy to the extent possible to reduce their oil burden. Similarly, the increasing cost of electrical power resulted in favourable economics for solar thermal systems in the domestic sector.

1.3 Barriers to solar thermal systems

In India, compared to the potential, actual penetration of solar thermal systems has been rather low. In India the installation of collector area per 1000 inhabitants is 0.52 m^2 as, which is low compared with penetration levels in countries like Germany and Greece where these figures are 5.1 m^2 and 15.2 m^2 respectively. Even with technological maturity and a relatively well-established manufacturing base, the growth of solar water heating systems has been constrained on account of technology, policy, and infrastructure related issues:

- The solar water heating systems are not readily available, particularly at the retail level. This means, that even for those users who are interested in installing solar systems, it is difficult to get the desired systems.
- There is a lack in the required level of sales, services, and maintenance infrastructure, which becomes an obstacle for market penetration.

- Considering the high up front cost of the solar systems compared with the conventional systems for same end-use
- Absence of pervasive micro-credit networks at present makes it difficult for the consumer, especially in peri-urban and small towns, to avail the credit. In this context, the aspect of energy service needs due consideration
- There is a lack of technical capacity that can help the potential users (i) in designing properly sized solar systems and (ii) in integrating them with the existing systems/processes. Since, for most of the industrial and commercia clients, solar heating is not their area of core competence, absence of such technical consultancy inhibits the growth of the sector.
- Though different agencies have been propagating solar water heating systems for over two decades, the awareness among potential users is still quite low. In a survey conducted in Haryana, it was observed that just over half of the respondents were aware of solar thermal systems.
- Another major barrier relates to the reliability of the suppliers of solar systems, in terms of after-sales service and maintenance. This is perceived t be very low by the potential market.

It may be noted that a majority of the manufacturers of solar thermal systems a present are small-scale entrepreneurs. As such they are unable to invest in (i) development of market support infrastructure in terms of sales and maintenance network, and (ii) product development and improvement.

2. Project objectives and rationale

2.1 Objectives

The overall objectives of the project are as follows:

- to increase market penetration of solar thermal technologies for low grade-heating application in India; and
- to help in reducing related GHG (CO_2) emissions

2.2 Rationale

Based on the survey in industrial and hotel sector in Haryana, the main barriers to the higher penetration of solar thermal systems could be summarized as:

- high up front cost of the system
- lack of after-sales and maintenance services
- lack of suitable financing schemes

- lack of technical capacity to provide consultancy for proper system designing/integration
- lack of awareness among users.

Based on national experience in propagating solar water heating systems through a variety of schemes, it is evident that in order to jump-start, there has to be an 'all-encompassing' set-up that can address the aforementioned barriers. The market-oriented solar energy services company (SESCo) model for the promotion of solar thermal systems is conceptualized on this premise.

The operationalization of the SESCo model would help in removing the barriers successfully, leading to higher penetration of solar thermal systems in industrial, commercial and domestic sectors. This would also provide the necessary push resulting in the leap-frogging of the solar water heating market. By offering a cost-effective alternative to fossil fuels and electricity, it would result in the reduction of CO_2 emissions.

The proposed project is in line with the objectives of the GEF Operational Programme No. 6 for Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs. The GEF funds will be primarily used for increasing the market by way of promoting a market-based model that addresses the existing barriers. It is noteworthy that the proposed model is not based on a general injection of funds in the form of any subsidy, but will offer a low cost loan and /or contingency fund to cover risk. This, in turn, would also attract greater involvement of the private sector, besides overcoming the barriers. A successful demonstration of the project model will spurt market growth rate, resulting in long-term benefits such as enhancement of the product quality and manufacturing capacity and establishment of market chains. This, through the economies of scale, would facilitate cost reduction of solar thermal energy over a longer time frame.

Reduction in consumption of fossil fuels and utilization of more efficient and cleaner technologies is one of the foremost priorities of the Government of India. Indeed, utilization of solar thermal energy for industrial process heating and for domestic purposes is one of the thrust areas for the Ministry of Non-conventional Energy Sources. Thus, the project is compatible with national priorities. Since the proposed project results in reduction in environmental pollution levels, it also helps in attaining a cleaner and healthier atmosphere for the populace at large.

2.3 Project description

The project aims to increase penetration of solar thermal systems by facilitating SESCos.

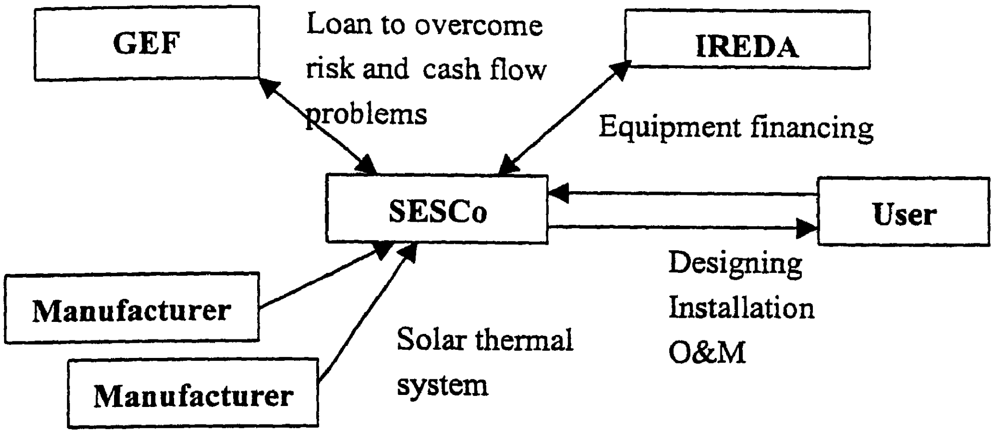
Solar energy services company (SESCo)

The solar energy services companies (SESCos) would operate on fully commercial basis, catering to the requirements of the potential users. It will offer the services as mainstream energy services rather than as renewable energy services. The SESCos would fill up the missing link between the manufacturer and the users by offering a variety of services such as installation of solar thermal systems, O&M, performance contracting, and technical consultancy. To meet the requirements of diverse users and end-use applications, the SESCo will offer its services with suitable options such as:

- energy supply against payments related to energy saved
- installation of solar thermal with O&M contract
- performance contracting
- technical designing/consultancy
- financing through the existing IREDA loan.

Payments for energy saved

The SESCos would outsource the solar thermal systems (or components) from manufacturer(s) and install the system at users' premises. The SESCo will avail existing provision of equipment financing by IREDA towards the cost of the solar thermal systems. But the users will be charged on the basis of the energy saved. Essentially, this would be a fixed amount based on the monthly average energy/cost saving on account of utilization of the solar thermal system. The very fact that the financial stability of a SESCo depends on the energy supplied by it, would ensure proper functioning of the systems as well as better product quality. Moreover, as the SESCo is meeting the capital cost, it will ensure optimal system designing. The operation of SESCo is shown in the block diagram below.



To begin with, the SESCo would focus on a judicious mix of domestic and higher capacity industrial/commercial systems. While the domestic systems do yield higher profits, on account of their smaller capacity and wider spread (or large geographical distribution), they also have higher transaction costs. On the other hand, in case of commercial/industrial systems, the profitability is low but the transaction cost too is low. Besides, in large capacity systems, there is greater scope of economies of scale. The SESCo, offering solar thermal systems on "payments for energy saved" option are financially viable as the NPV is positive. Detailed financial viability for a solar thermal system of 1000 litres per day capacity is shown in annexure D.

However, the SESCos may not limit itself to the "payment for energy saved" option only and will offer a basket of options to the customer, catering according to the market demand.

The study carried out for assessing the potential for solar thermal systems in industrial sector in Haryana indicated that the majority of the potential users have proffered the 'payments for energy saved option' (57% as against 20% who will buy solar thermal under present arrangements). Thus, even as the SESCo is offering all options, the 'payments for energy saved' will be the major component.

Though the solar thermal systems using flat plate collectors will be offered by SESCos, as theses are technically, and commercially proven, but other type of collectors e.g. evacuated tube collectors, concentrating collectors could also be offered depending on assessment of commercial viability by the SESCos.

Project design

The SESCo model can successfully overcome the barriers to the penetration of solar thermal systems. The important barriers it will address directly are:

- high up front cost of the system
- lack of after-sales and maintenance services
- lack of suitable financing schemes
- lack of technical capacity for system sizing and integration
- non-reliability of the suppliers in terms of after-sales back up

Along with the formation of the SESCo, the project also addresses the issues of awareness and technological capacity building.

The project model is designed to facilitate the formations of SESCos by establishing institutional structure for providing financing in terms of loan and contingency fund to cover the risk.

The proposed model was well received during the interaction with the stakeholders, including the MNES and end-users. The user's preference has also been indicated in the study. There is a clear preference for the SESCo concept over the existing financing arrangements. It is indicated that even if all other barriers were removed, the SESCo model could result in a greater diffusion of solar water heating systems, thereby propelling the growth rate of market for solar thermal systems.

But, on the flip side, the private investor is likely to view this as a high-risk venture, since the returns are distributed over longer period of time and large number of clients. Furthermore, since the model becomes self-sustaining with large turnover (in terms of installations), it will take a few years to build. To mitigate this risk perception, and in order to entice private sector players to come forward to build up the market, low cost financing from GEF is required.

One of the key components of the proposed project design is the strengthening of the SESCos by addressing their cash flow problem till sufficient market penetration rate is achieved. Other features include risk mitigation, awareness and capacity building, as well as creating conducive institutional mechanisms. Approximately 80%–85% of the GEF funds will be used mainly towards low cost loans and contingency fund, and a small component of the grant (up to maximum of 10%) will be used for non-commercial activities such as technical capacity building or partially helping in building the infrastructure for SESCo. The grant component would reduce over time. A small component of GEF funds will be used for awareness and capacity building of stakeholders.

The SESCos will have the flexibility to design the sub-proposals according to the requirements of the consumers/market, and the risk perception. However, the SESCo sub-proposals will be evaluated based on previously laid down criteria, such as business projections, how they address the barriers, proposed strategy and financial strength, etc. Further, the GEF loan and the grant component level will be proportional to the cost of systems proposed to be installed, the upper limit being 35% (25% loan and 10% grant) of the total cost.

With a very high potential for the application of solar thermal systems, it expected that a minimum of six SESCo would start operation within the project period of six years. These six SESCos would collectively install about 132,000 m^2 over the project period.

The SESCo could be formed by any of the following:

- Existing manufacturers of solar thermal systems
- New private companies
- Co-operative sector
- State government organisations

3. Project activities and expected results

3.1 *Institutional framework for SESCos*

Objectives

- To set up institutional linkages to finance SESCos
- To create a loan fund for SESCos
- To prepare the appraisal methodology for assessing potential SESCos
- To formulate the legal framework for SESCos

Description

This activity focuses on the preparation of the framework under which SESCos will operate, which that includes devising criteria for selection and financing. A revolving fund (along with the guidelines for lending) will be created to provide low cost loans to the SESCos. The executing agency, i.e. MNES will appoint a fund manager to oversee the financing part for the SESCos. Further, MNES will appoint the Project Manager for independent technical and financial appraisal of proposals received from potential SESCos. This activity also focuses on the preparation of methodology for the appraisal of SESCo proposals, along with the preparation of proper evaluation criteria. Another important task under this activity is to draw the legal framework, which will provide a basis for agreements between the SESCo and the actual user of solar thermal systems. This task would draw from the operational experiences of IREDA – the financing arm of the MNES – in the field of co-generation.

Expected results

- Institutional framework for operationalizing SESCos
- Guidelines for financing SESCos
- Evaluation criterion of SESCo proposals
- Legal guidelines for agreement(s) between SESCos and users.

3.2 Awareness and capacity building of stakeholders

Objectives

- To build awareness about solar thermal systems
- To build awareness about SESCos
- Capacity building of stakeholders.

Description

One of the major barriers to large-scale adoption of solar thermal systems relates to lack of awareness as well as misconceptions about the maturity and reliability of the technology. The awareness creation task will be undertaken in such a way that it complements and enhances the ongoing activities of the MNES and state agencies. This will include organization of workshops and seminars in the areas where the project is being implemented. These efforts will focus on specific market segments and will be designed to cater to the needs of that sector e.g. textile sector in case of towns like Panipat and Faridabad.

For the successful implementation of the project, it will be essential to disseminate the SESCo concept to the potential investors, which include new as well as existing players in the sector. This would ensure maximum leverage to the awareness drive.

The capacity building exercise, which focuses on technological capacity building, is an essential component of this task. This includes training to the appropriate professionals in designing/optimisation and integration of the system for specific end use/sectors.

In addition, this task would undertake confidence-building measures among the possible investors in the project model and encourage greater participation. Different scenarios for the possible business prospects with the proposed project/model will be presented to them.

Expected results

- Enhanced awareness about the use of solar thermal technology
- Awareness about the project model and business prospects
- Confidence among stakeholders about the viability of SESCos
- Heightened technical capability for system design and integration.

3.3 Facilitation of SESCos

Objective

To operationalize the SESCo model to foster and accelerate the rate of penetration of solar thermal systems.

Description

One SESCo would be supported initially to demonstrate the workability of the concept and to build confidence among the potential proposers. This SESCo will start operations in the district of Panipat in Haryana, where large numbers of textile units of various sizes are situated, thereby demonstrating the operation of SESCo. The potential solar thermal systems in industrial sector of Panipat is described in the annexure E.

With the institutional structure and financing arrangements in place, the proposals for forming SESCos will be solicited. The existing promotional media will be used extensively, so that the information reaches all potential proposers. The proposals will be evaluated for their techno-commercial strength. It is expected that, with the demonstration of the SESCo, the subsequent proposals will be competitive investment proposals, outlining achievable market penetration targets. The focus area for the project is the North Western states of Haryana, Punjab, and Rajasthan, but that is not limiting, in the sense that proposals will also be sought from other states, thereby ensuring faster execution of the proposed activities.

Though the GEF funds are used mainly as low cost debt, it is proposed to provide these annually. The support for the first year will be based on projections. In the subsequent years, the financial support to the proposer will be directly linked to its performance. The repayments from the SESCos will replenish the loan fund, which will be used for breeding more SESCos.

Expected results

- One SESCo operational in second year of project

- Investment proposals from potential SESCos
- Formation of SESCos in the states of Haryana, Punjab and Rajasthan
- Installation of solar thermal systems by the SESCos.

3.4 Project co-ordination and monitoring

Objectives

- To implement and monitor the mechanism proposed in the project
- To disseminate the acquired experience related to the operational aspects of SESCos.

Description

MNES will coordinate the project along with the state nodal agencies (SNAs) - HAREDA, PEDA and REDA. TERI will provide necessary technical inputs as well as independent monitoring and evaluation. A steering committee will be formed for overall guidance and policy level directives. This steering committee will include representatives from MNES, state agencies, and UNDP, along with the representation of users and industry associations. The project manager and fund manager would assist this committee.

Expected results

- Timely execution of various project activities
- Annual, mid-term, and long-term monitoring of the project
- Documentation and dissemination of project results.

Activity schedule

Activity/year	1		2		3		4		5	
1. Institutional framework for SESCo	→									
2. Awareness and capacity building of stakeholders	—	—	—	—	→					
3. Facilitation of SESCos			—	—	—	—	—	—	—	—
4. Project coordination and monitoring	—	—	—	—	—	—	—	—	—	—

3.5 Impact of the project

Considering the fact that the proposed project offers solar energy services at costs comparable or lower than the present conventional fuel costs, it would result in manifold increases in the market-share, and would subsequently exert a market pull. Not only this, the project would also induce a much faster growth rate of the solar thermal market in the country. Further, as direct subsidies are not being offered, the sustainability of the market will encourage private investment from players who have a longer term interest in this field.

It is expected that, with this intervention, the systems' penetration will increase from 3000 m^2 per annum in the three states of Haryana, Punjab and Rajasthan, to 7500 m^2 in the first year of implementation of the SESCos.

Global benefits

The successful implementation of the project will demonstrate the viability of offering solar thermal energy services as any other conventional energy-based services. At a very conservative estimate (taking into account the effect of systems installed only during the project period and not considering the long-term, rippling effects of the project) installations as result of the project could be to the tune of 132,000 m^2. The resultant CO_2 savings would then be 45,000 tons per annum or 0.95 million tons over the lifetime of 20 years.

This would have a cascading effect in other South Asian countries as well, which on the one hand have similar solar resource availability, and, on the other hand, spiralling energy demands.

Domestic benefits

The successful demonstration of the proposed business model, which addresses the major barriers in a very comprehensive manner, would have a longer-term impact in terms of mainstreaming solar thermal systems as well as enhanced private participation in the solar thermal markets.

The greater use of solar thermal systems, especially in the industrial and commercial sectors, would reduce dependence on the imported fossil fuels, thereby facilitating energy security. The use of solar thermal systems would reduce local pollution, which is becoming a sensitive issue for the industrial sector, with growing concern for the environment and stringent pollution laws. The projected installation of 132000 m^2 of solar thermal systems would reduce conventional fuel consumption by 8200 tons of oil equivalent/annum in commercial and industrial sector and 16 million units of electricity in domestic sector. In case of solar thermal systems in the domestic sector, they save electrical power, which could be used for more productive purposes. Indeed, propagation of solar thermal systems could be an effective demand side management (DSM) tool.

4. Risk and sustainability

The proposed project envisages a very different model for the promotion of sola thermal technologies, which essentially is fully investment-oriented. Thus, there are risks associated with it. These risks have been kept to minimum by the incorporation of various measures discussed below.

4.1 Risks

Non-participation from private players

Since a very new kind of project model has been proposed, which expects high quality and long-term participation, there is the risk of not receiving enough and/or technically and financially strong proposals for the formation of SESCos It is to counter this that the capacity-building component has been designed. This capacity building would involve projection of various business scenarios to the potential investors or SESCos through business and stakeholders' meets. Along with this, the awareness-building component is planned to sensitize the market. The market study has indicated encouraging results for this concept. Thus, the higher market potential will induce greater participation. Initially, in order to demonstrate the concept, it is proposed to form one SESCo under HAREDA. This step would build up confidence in the workability of the concept under normal market conditions.

Slow or no repayments

The repayment risk is a standard financial risk, but gets increased in this case with the introduction of a new model. Though this would not affect the project and projected scenarios, as the incremental cost and global benefits are estimated for the SESCo starting in the project period, it would affect the replicability, as the repayments are contributing/replenishing to the loan fund. The business scenario indicates that the returns are high for SESCos, provided they are supported in the initial period. This means that, to lower this risk, the following are needed:

- Stringent evaluation criteria for the proposals from SESCos
- Sharing risk with the SESCo
- The project fund allocation linked with the performance

Inferior quality of systems/service

The inferior quality of the systems installed by the SESCo could result in non-payments from the user. This risk is addressed in two ways, namely (i) the present practice of providing loans for solar thermal systems, which uses BIS-approved collectors, will ensure better quality of solar collectors, and (ii) the capacity-building component is designed to provide technical training in terms of proper system designing, integration and optimization.

Repayments from the user to the SESCo

The non-payments risk was felt by all the stakeholders as major risk. In case of the payments for energy saved mode of operation, there is the risk of the user not paying the SESCo due to a number of reasons. The most prominent one concerns actual reduction in thermal energy requirement. To overcome this risk, the SESCo will have an agreement with the user in which all such eventualities will be covered properly. The SESCos can also use the contingency fund available to partially cover this risk. In addition the SESCo can also built in provision of deposit from user in its contract to ensure commitment from the user. This deposit could be used in case the system needs to be relocated.

4.2 Sustainability

So far the major thrust of government programmes in the solar thermal field has been on removing only one barrier, i.e. of the initial high cost through the provision of interest subsidies. This project is designed to involve all the stakeholders in establishing the SESCo model, which provides comprehensive solar thermal energy services. Through establishment of the SESCos, the project inherently builds a network of marketing, sales, and maintenance. Thus, the proposed project model presents a sustainable path, thereby increasing the market penetration rates for solar thermal systems.

As the GEF financing is related to the performance, the SESCos would make efforts for maximum market creation and selection of optimum strategy. With initial support, the SESCos become self-sustaining within the project period as a result of returns from the systems installed in the initial years. Thus, after the initial years, the SESCo will have established the network and created a market to sustain the business.

Furthermore, the successful demonstration of the establishment and working of SESCos will build confidence in other players, ensuring the replicability of the model. The market potential in India is quite high, so that a large number of SESCos can operate profitably.

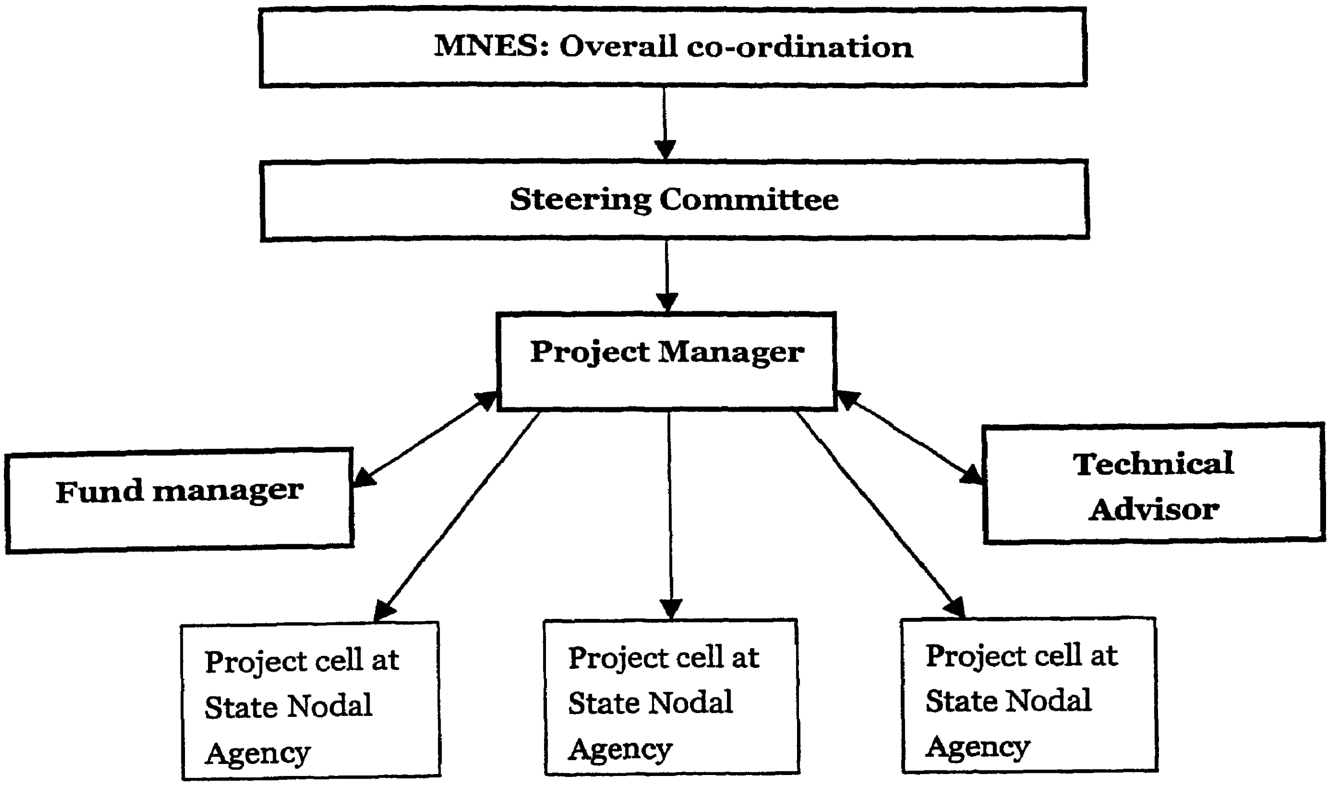
5. Stakeholders' participation and implementation arrangements

5.1 Stakeholders' participation

In order to ensure the success of the proposed project and that of the SESCo; say, the relevant aspects have been discussed with all the stakeholders viz. the potential users, existing manufacturers of solar thermal systems, experts from MNES, and R&D institutions. In order to get first-hand inputs from potential users regarding their perception of the barriers as well as their reaction to the proposed project for addressing the same, two interaction meetings were organized. The first meeting was organised in Faridabad, in October 2001, an the second meeting was organized in the town of Panipat in December 2001. These meetings were attended, among others, by the representatives of the industries' associations, small-scale industries' associations, and potential use from different industrial sectors such as textiles, and food processing. The project model was discussed with them and various suggestions received for th project design. It was suggested that the scope of SESCo should not be restrict to one single type of operation, (such as providing energy services only and no installing user-owned solar systems). These exercises were complemented by market survey, which brought get inputs from the larger section of the users, including small, medium, and large industries, and hotels.

5.2 Implementation arrangements

The MNES will look after the overall execution of the project. For this purpose steering committee will be formed with members drawn from the MNES, the UNDP, the IREDA, and SNAs like HAREDA, PEDA, and REDA. The steering committee will oversee the functioning of the project cell and the project management team, towards the implementation of project activities, and provide guidance for the same. Initially, in the first one-and-a-half years of project implementation, it is proposed that the steering committee meet every quarter to review the work done. In this period, crucial project activities like th formation of institutional and financing framework, preparing guidelines for SESCos, preparing guidelines for SESCo-user agreements, and solicitation and evaluation of proposals from SESCos, will be undertaken. After this period, the steering committee will meet once in six months so as to assess the progress of the project. The implementation arrangement and linkage between different agencies is explained below.


MNES: Overall co-ordination
Steering Committee
Project Manager
Fund manager
Technical Advisor
Project cell at State Nodal Agency
Project cell at State Nodal Agency
Project cell at State Nodal Agency

Project cells will be formed at the SNA level to implement activities at the state level, the advantage being that the states, which want benefit from this project will encourage the state-level stakeholders to participate in project activities. One of the main tasks of the project cell would be to create awareness about the SESCo concept and to induce and to help potential SESCos prepare the proposals. The responsibility of the project cell would be to implement the project based on guidelines provided by the steering committee. This includes solicitation of proposals for support from SESCos, providing inputs during evaluation of proposals and monitoring the implementation.

A central PM (project manager) will be appointed to coordinate the project. The responsibility of the PM is to prepare a detailed roadmap for the project implementation. Major responsibilities of the PM include the preparation of guidelines for financing SESCos; preparing evaluation criteria for SESCo proposals in co-ordination with the steering committee and the technical adviser; and solicitation and critical evaluation of proposals from SESCos.

A fund Manager will be appointed under the project, because the project proposes to offer GEF assistance in a fully commercial mode. The financial appraisal of the project proposals and the handling of the funds are major responsibilities of the fund manager. The fund manager would also guide the SESCos on the financial matters during negotiations.

A TA (Technical Advisor) would provide inputs to the steering committee, project Manager, and fund manager so far as technical issues are concerned. The TA will also share the responsibility of the execution of capacity building of the SESCos. The TA will also participate in the monitoring of the project.

6. Incremental cost and project financing

6.1 Incremental cost

Though solar thermal systems are viable on a life cycle cost basis, there do exist some barriers to their large-scale propagation including high initial costs. The SESCo model has been designed to overcome these barriers. The incremental cost analysis is based on the costs for promotion, and long-term sustainability o SESCos for removal of barriers. These costs include the low-cost financing for SESCos in order to cover the higher risk due to investment distributed over a large number of small projects and financial returns spread over a very long period.

Baseline scenario

The baseline scenario is the business as usual with the continuation of the present mode of activities at present levels. This means that the barriers to the penetration of solar thermal systems remain, restricting the annual installation of solar thermal systems to the present levels of 50,000–60000 m^2/annum of collector area. The annual installations in the North-Western states of Haryana, Punjab and Rajasthan are 3500 m^2/annum. Thus, in the absence of the proposed interventions, the majority of the potential users of solar thermal systems would continue to use the conventional fuels, i.e. mainly diesel/fuel oil in case of the industrial and commercial sectors, and electrical power in case of the domestic sector. The baseline cost primarily includes the cost of conventional fuel being used in the domestic, industrial, and commercial sectors to meet the thermal energy requirement by the potential users. The baseline, based on the fuel consumption to meet the thermal energy requirements equivalent to the solar thermal systems projected to be installed in the alternate scenario, are estimated to be 24.64 million dollars.

Alternate scenario

The alternate scenario pertains to the facilitation of the SESCo concept, as well as promotion and formation of SESCos, leading to a higher rate of installation of solar thermal systems. It is estimated that the proposed intervention would result in an additional installation of 132,000 m^2 of collector area. The total costs to achieve this penetration level are estimated to be 34.09 million dollars (refer to annexure C for details). The costs include awareness and capacity building efforts, the cost of solar thermal systems, and financial support to the SESCos in the initial years of their operation. Since the solar thermal systems are economically viable, in the alternate scenario of solar system installed by SESCos, the cost to the user is lower than the baseline cost of meeting thermal energy requirements. The incremental cost, which is cost for removal of barriers through promotion of SESCos, is estimated to be 11.30 million dollars (refer to annexure A for details). These costs include awareness and capacity building efforts and financial support to the SESCos in the initial years of their operation. A large portion of the project costs, US$ 22.71 million is for solar thermal systems, to be borne by the users of the systems.

6.2 Project financing

The total project cost is estimated to be 34.09 million dollars. A major part of this cost, equivalent to 22.71 million dollars, will be the contribution of the actual users towards the solar energy services offered[1]. The MNES will extend the existing interest subsidies towards the additional systems installed as a result of this intervention. The interest subsidy requirement works out to be 3.00 million dollars. In addition the MNES as well as the SNAs will be providing co-financing for awareness and capacity building. The financing plan is given in tables 1 through 3.

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[1] The equity participation from the potential SESCo as well as the capital cost of solar thermal systems is reflected in the user's payments for the services, and hence, to avoid double counting, the capital cost and investment by the SESCo are not included in the cost estimations.

Table 1 Project budget

Activity/year	1	2	3	4	5	6
1	0.05	0.00	0.00	0.00	0.00	0.00
2	0.16	0.05	0.05	0.00	0.00	0.00
3	0.00	1.88	3.76	5.65	9.41	12.55
4	0.09	0.09	0.09	0.09	0.09	0.09
	0.30	2.02	3.90	5.74	9.50	12.64

Table 2 Global Environmental Facility cost

Activity/Year	1	2	3	4	5	6
1	0.05	0.00	0.00	0.00	0.00	0.00
2	0.13	0.02	0.02	0.00	0.00	0.00
3	0.00	0.43	0.85	1.28	2.13	2.84
4	0.08	0.08	0.08	0.08	0.08	0 08
	0.26	0.53	0.95	1.36	2.21	2.92

Table 3 Total budget by source of funding

Activity/Agency	GEF	MNES	SNA	USER	Total
1.00	0.05	0.00	0.00	0.00	0.05
2.00	0.17	0.05	0.028	0.00	0.25
3.00	7.54	3.01	0.00	22.71	33.25
4.00	0.48	0.00	0.056	0.00	0.54
	8.24	3.06	0.08	22.71	34.09

7. Monitoring and evaluation

It is expected that the proposed project will trigger investments. The fact, that the concept of an energy services company will be tried out for the first time in India necessitates having a proper monitoring mechanism. The monitoring mechanism will help in ensuring the effectiveness of the programme by way of suggesting course-correction measures, if and when required. The monitoring framework would be based on the indicators explicitly mentioned in the logical framework (refer to annexure B). In order to negate any bias in this regard, it i proposed to have an independent, technical organization, responsible for monitoring and evaluation of the project.

The monitoring and evaluation shall be undertaken in two distinct phases:

- Project design phase
- Project implementation phase

Project design phase

During the project design phase, the steering committee along with the project manager will design the project implementation phase and guidelines for SESCo business proposals. The guidelines will be developed and discussed with the investor community. This interaction will provide very crucial self-monitoring and guiding parameters during the project design phase.

Apart from providing feedback to brainstorming sessions, based on deliberations with the investor community, the project manager will also submit quarterly progress reports.

Project implementation phase

After the formulation of guidelines and its subsequent approval by the steering committee, project cells at state level will be formed to solicit proposals for the creation of SESCos.

The real monitoring will start after the completion of the due diligence process, which will include the project management aspects as well as financial modelling of various business plans submitted by the prospective SESCos.

During the investment-cum-implementation phase, it is proposed that an independent monitoring agency be appointed to oversee the working arrangement and implementation of solar thermal systems in industrial, commercial, and domestic sectors. Some of the parameters against which monitoring will be carried out are:

- design of complete solar thermal system, including balance-of-system (as per guidelines);
- financing arrangement of sample projects between the SESCo and the users;
- assessment of the capacity of SESCos for handling various projects;
- upkeep of standard documents, including those pertaining to accounting and book keeping;
- responsive and quick assessments, especially those related to service parameters; and
- assessment of inventory and spares' management.

The above list is indicative, and it is understood that this will be designed after taking into consideration all the aspects of the final project.

Annexure A: Incremental costs

Activity	*Baseline*	*Alternate*	*Incremental*
1. Institutional framework for Solar Energy Services Company	The existing arrangement for equipment financing through IREDA, Testing of solar collector in SEC. No institutional arrangements exist for SESCos. **Cost 0 0 million dollars**	The institutional structure to foster, finance, and multiply SESCos. Builds upon the existing institutional structure **Cost: 0 05 million dollars**	The institutional support to the SESCos with low cost debt to increase private participation **Cost: 0.05 million dollars**
2. Awareness and capacity building of stakeholders	Awareness efforts by MNES, SNAs. However, the level of awareness among the potential users is very low Capacity to provide technical consultancy is sparse and not available easily. **Cost 0 08million dollars**	Stepping up of the awareness efforts, capacity building of potential SESCos to provide the solar energy services on commercial conditions to enhance the market. **Cost: 0.25 million dollars**	The enhanced and focused awareness campaign Capacity building of potential SESCos about the SESCo concept In addition, technical capacity building to provide better quality services **Cost: 0 17 million dollars**
3. Formation of SESCos.	The solar thermal systems are being installed by the manufacturers with the existing means of equipment financing from IREDA. The present rate of installations over India is a meagre 50,000-60,000 m^2 per annum. The barriers are high cost, availability, after-sales arrangements, systems designing and integration, the solar system being an additional investment for meeting the same requirement of thermal energy. A majority of users continues to use the conventional fuels **Cost 0.0 million dollars** In absence of the SESCos the conventional fuels continue to be used bot low temperature thermal requirements. The fuel costs, equivalent to the replacement by solar thermal systems in alternate case, are 24 56 million dollar.	The SESCo receives financial support to overcome the risk and cash flow problems. With the formation of the SESCo, the solar energy services are being offered on fully commercial terms. The SESCo offers solar thermal systems with options suitable to the users' needs, including the payments for energy saved Focuses on building the market, building the infrastructure for after-sales and distribution Thus overcoming the major barriers for the penetration of solar thermal systems. The actual user pays for solar thermal systems in terms of payments less than or equal to the present cost. The removal of barriers result in increased penetration of solar thermal systems **Cost:10.54 million dollars** The solar systems are installed through SESCo, the user pays at least 10% lower than the present fuels cost for the thermal energy supply The increased market for solar thermal systems results in installation of 132,000m2 of solar	Solar thermal systems are being offered on a commercial scale, with options suitable to diverse requirements of users This has resulted in the increased market penetration of solar thermal systems, demonstration of the SESCo concept and the development of distribution and after-sales network **Cost: 10.54 million dollars** Higher penetration of solar thermal systems replacing the conventional fuels like diesel, electricity

Activity	*Baseline*	*Alternate*	*Incremental*
	Cost. 24.56 million dollar	collector area in industrial, commercial and domestic sector through SESCos Cost 22 71 million dollar	Cost 0 00
4. Project co-ordination and monitoring	None exists presently **Cost 0.0 million dollars**	Project coordination and monitoring by way of appointing/designating specific personnel and independent organization(s) with sufficient technical capacity and experience in the field Includes the development of roadmaps for the promotion and financing of SESCos based on well-structured systems as well as on checks and balances **Cost: 0 54 million dollars**	The formation of SESCos through the implementation of the project incremental to the existing mode of promotion of solar thermal systems. **Cost: 0.54 million dollars**
Global benefits	The lower rate of penetration of solar thermal systems leads to higher dependence on fossil fuels	The increased rate of the market penetration of solar thermal systems in the industrial, commercial, and domestic sectors as a result of the demonstration and promotion of SESCos. As result of the high utilization of solar thermal systems the CO_2 saving are 0 9 million tons over the lifetime of the systems installed as a direct result of the project in the project implementation period.	The reduction in GHG emissions by 0 9 million tons of CO_2 Demonstration of the SESCo concept, which could be replicated in the South Asian region
Domestic benefits	The progress of solar thermal *programme remains* at the present level of penetration. The potential users continue to use conventional fuels for meeting the thermal energy requirements Thus high dependence on imported fossil fuels and resultant local pollution	New private investment in the solar thermal sector. Demonstration of SESCo model which could be replicated Lesser dependence on imported fossil fuels and hence reduction in local pollution	Reduction in dependence on conventional fuels, local pollution. Leveraging of private investment *in renewable energy sector*
Total cost (million dollar)	24.64	34.09 GEF· 8.24 Co-financing: 25.85 (User 22 71, MNES 3.06, SNA 0.08)	Incremental cost. 11.30 GEF. 8.24 MNES. 3.00 SNA. 0 06

Annexure B: Logical framework

	Indicators	*Means of Verification*	*Assumptions*
Goal Promotional of solar thermal technology by removing barriers, thereby reducing GHG emissions	Total capacity installed.	Market surveys, indicated changes in energy consumption patterns in different sectors of economy.	
	Change in fuel consumption pattern	Reports from industry associations and renewable energy equipment manufacturers.	
Objective Accelerate penetration of solar thermal systems in India through promotion of SESCos	Increased rate of installations of solar thermal systems	Annual report from MNES/SNAs/IREDA/independent monitoring. Disbursement of loans from IREDA.	Increased installations as a result of this intervention. Market infrastructure in place to fulfil the increased demand
	Increase in involvement of private players offering solar thermal systems energy.	Requests for support from private investors to start, diversify, and expand business in solar thermal systems.	
Outcome Increased market size Increased awareness about solar thermal systems Solar energy services offered as mainstream commercial energy	Number of solar energy services companies formed. Number of requests for solar thermal systems.	Number of systems installed by the SESCos over years. Number of queries generated	The acceptance of the concept of the SESCo as an effective means of market penetration The attractiveness of the concept to attract private investment Long-term interest of investors in the field
Project activities 1 Institutional framework for the SESCo	Formation of an effective framework for operationalizing the project, including financing arrangements	Guidelines/arrangement for the formation of SESCo including financial guidelines	The guidelines and the institutional set-up for SESCos are simple (and expeditious) enough to entice potential investors
2 Awareness and capacity building off stakeholders	Organization of workshops, interaction meetings, with potential users and stakeholders.	Proceedings of the workshop Outcomes/suggestions from workshop	The awareness generation and capacity building, translating into market enhancement
3 Formation of SESCo	Five to six SESCos formed as per projections	Commercial operation of SESCo	*SESCo offers solar thermal systems on full commercial mode*

Annexure C

Cost estimations for Baseline and Alternate Scenario

(all costs in Indian Rupees)

Installation of solar thermal systems in terms of collector area (sq. m) in alternate scenario

Year	1	2	3	4	5	6	Total collector area
Commercial and industrial		6000	12000	18000	30000	40000	106000 m^2
Domestic		1500	3000	4500	7500	10000	26500 m^2
							132500 m^2

Baseline scenario

In absence of solar thermal systems the conventional fuels (diesel/furnace oil in industrial sector and electricity in domestic sector) are used.

The baseline scenario estimates costs of fuels used to generated heat equivalent to the solar thermal systems installed in alternate scenario

Cost of energy for heating 1000 lit water per day (diesel + boiler)	26550 65	Rs
cost of energy for heating 100 lit water per day (electrical geyser)	3981 25	Rs
CO2 emissions for heating 1000 lit water (diesel + Boiler)	4841 589	Kg/annum
CO2 emissions as a result of heating 100 lit water (Electrical Geyser)	1459 792	Kg/annum
Discounting rate	0 12	

Year	1	2	3	4	5	6	7	8	9	10
Fuel cost (Diesel	0	7965194.11	8363454	8781627	9220708	9681743	10165830	10674122	11207828	11768219
in industrial and commercial sector)			15930388	16726908	17563253	18441416	19363486	20331661	21348244	22415656
(Rs/annum)				23895582	25090361	26344880	27662123	29045230	30497491	32022366
					39825971	41817269	43908133	46103539	48408716	50829152
						53101294	55756359	58544177	61471386	64544955
Fuel cost (Electricity		2985937.5	3135234	3291996	3456596	3629426	3810897	4001442	4201514	4411590
in domestic sector)			5971875	6270469	6583992	6913192	7258851	7621794	8002884	8403028
(Rs/annum)				8957813	9405703	9875988	10369788	10888277	11432691	12004325
					5971875	6270469	6583992	6913192	7258851	7621794
						7962500	8360625	8778656	9217589	9678469
Total baseline cost	0	10951131 61	33400951	67924394	1.17E+08	1 84E+08	1 93E+08	202902089	2 13E+08	2 24E+08

11	12	13	14	15	16	17	18	19	20	21	22	23
12356630	12974462	13623185	14304344	15019561	15770540	16559066	17387020	18256371	19169189			
23536439	24713261	25948924	27246370	28608688	30039123	31541079	33118133	34774040	36512742	38338379		
33623484	35304658	37069891	38923386	40869555	42913033	45058684	47311619	49677199	52161059	54769112	57507568	60382946
53370610	56039140	58841097	61783152	64872309	68115925	71521721	75097807	78852698	82795332	86935099	91281854	95845947
67772203	71160813	74718853	78454796	82377536	86496413	90821233	95362295	100130410	105136930	110393777	115913465	121709139
4632169	4863778	5106966	5362315	5630430	5911952	6207550	6517927	6843823	7186015	7545315		
8823179	9264338	9727555	10213933	10724629	11260861	11823904	12415099	13035854	13687647	14372029	15090631	
12604542	13234769	13896507	14591333	15320899	16086944	16891291	17735856	18622649	19553781	20531470	21558044	22635946
8002884	8403028	8823179	9264338	9727555	10213933	10724629	11260861	11823904	12415099	13035854	13687647	14372029
10162392	10670512	11204037	11764239	12352451	12970073	13618577	14299506	15014481	15765205	16553466	17381139	18250196
2.35E+08	2 47E+08	2.59E+08	2.72E+08	2 86E+08	3E+08	3 15E+08	3 31E+08	347031429	364383000	362474502	332420348	333196203

NPV	1179 334504 million Rs									
Baseline cost	**24.57 million US$**									
Annual CO2 emission (ton/annum)		0	2547.32	7641.961	15283 92	28020 52	45002 66	45002 659	45002 66	45002 66
Total CO2 emissions (ton)	**953547.8611**									

Alternate scenario

Installation of solar thermal systems in terms of collector area (sq. m)

Year		1	2	3	4	5	6	7	8	9
Commercial and industrial			6000	12000	18000	30000	40000			
Domestic			1500	3000	4500	7500	10000			
Users payments for energy		0	9856018	30060856	61131954	1 05E+08	1.66E+08	173916076	1 83E+08	1 92E+08
Users deposit			2700000	5724000	9101160	16078716	22724585			
NPV of users contribution	1090257589									
Loan/contingency fund for SESCo	281642306									
Grant to SESCo	80044761									
Capacity and awareness building	40038000									
Interest subsidy		0	0	2835000	8845200	18401418	34929695	57684859	55384682	50974173
NPV of interest subsidy	144253155									
Total cost (Rs)	1636235811	0	12556018	38619856	79078314	1 4E+08	2.23E+08	231600936	2 38E+08	2 43E+08

Total cost **34.09 million dollars**

45002 66	45002 66	45002.66	45002.66	45002 66	45002.66	45002 66	45002.66	45002.659	45002.659	45002.659	45002 659	45002 659
10	11	12	13	14	15	16	17	18	19	20	21	22
2 01E+08	2 11E+08	2 22E+08	2 33E+08	2 45E+08	2.57E+08	2 7E+08	2 83E+08	297455510	312328286	327944700	326227051	299178313
											-2699999	-5723999
43581063	36187952	28794842	21401731	14362996	8075535	2982602						
2 45E+08	2 48E+08	2 51E+08	2 54E+08	2 59E+08	2 65E+08	2.73E+08	2.83E+08	297455510	312328286	327944700	323527052	293454314

Annexure D
Financial analysis SESCo model

Cost of solar system	135	Rs/lit					
Loan	0 8	interest	9%	Fuel replaced	Diesel	Deposit from user	5 00%
Equity	0 2			Cost of fuel (Rs/lit)	17		
Corp tax	35%			Boiler efficiency	70%		
				Number of working days	300		
Collector area	20	sq m		Yearly instalment less than the baseline	10%	Escalation in yearly instal	2 00%
Capacity	1000	lit. per day		Calorific value (Kcal/lit)	8964		
Cost	135000	Rs		O&M	2%	O&M escalation	5%
Loan	108000	Rs		Salaries etc	3%		
Equity	27000	Rs		Yearly instalment (0 9* annual fuel saving)	25602	Fuel saving (Rs /annum)	28447 12182

Year	1	2	3	4	5	6	7	8
Income (A)								
energy sales	25602	26114	26637	27169	27713	28267	28832	29409
Total	25602	26114	26637	27169	27713	28267	28832	29409
Expenditure (B)								
O&M+salaries	6750	7088	7442	7814	8205	8615	9046	9498
Net income (A-B)								
PBDIT	18852	19027	19195	19356	19508	19652	19787	19911
depreciation	9639	9639	9639	9639	9639			
PBIT	9213	9388	9556	9717	9869	19652	19787	19911
interest payments	9720	9720	9720	8505	7290	6075	4860	3645
PBT	-507	-332	-164	1212	2579	13577	14927	16266
Tax	0	0	0	433	921	4847	5329	5807
PAT	-507	-332	-164	779	1658	8730	9598	10459
Inflow (C)								
PAT	-507	-332	-164	779	1658	8730	9598	10459

9	10	11	12	13	14	15	16	17	18	19	20
29997	30597	31209	31833	32470	33119	33782	34457	35147	35850	36567	37298
29997	30597	31209	31833	32470	33119	33782	34457	35147	35850	36567	37298
9973	10471	10995	11545	12122	12728	13365	14033	14734	15471	16245	17057
20024	20126	20214	20289	20348	20391	20417	20425	20412	20378	20322	20241
20024	20126	20214	20289	20348	20391	20417	20425	20412	20378	20322	20241
2430	1215										
17594	18911	20214	20289	20348	20391	20417	20425	20412	20378	20322	20241
6281	6751	7216	7243	7264	7280	7289	7292	7287	7275	7255	7226
11313	12160	12998	13046	13084	13112	13128	13133	13125	13103	13067	13015
11313	12160	12998	13046	13084	13112	13128	13133	13125	13103	13067	13015

Debt	108000							
Equity	27000							
Depreciation	9639	9639	9639	9639	9639	0	0	0
User's deposit	6750							
Gef loan	0							
Total	150882	9307	9475	10418	11297	8730	9598	10459
Out flow (D)								
Principal			13500	13500	13500	13500	13500	13500
Capital cost	135000							
return deposit								
Total	135000	0	13500	13500	13500	13500	13500	13500
Net cash (c-d)	15882	9307	-4025	-3082	-2203	-4770	-3902	-3041
NPV [redacted]	[redacted] Rs							

0	0	0	0	0	0	0	0	0	0	0	0
11313	12160	12998	13046	13084	13112	13128	13133	13125	13103	13067	13015
13500	13500										
											6750
13500	13500	0	0	0	0	0	0	0	0	0	6750
-2187	-1340	12998	13046	13084	13112	13128	13133	13125	13103	13067	6265

Annexure E: Potential for solar thermal systems in industrial sector of Panipat, Haryana

The Panipat district of Haryana has large number of small-scale industries (SSI). Majority of the small-scale units are in the textile sector. The distribution of SSIs is as given below.

No	Type of industry	Number of small scale industrial units
1	Textile	304
2	Agro based	43
3	Food products	16
4	Chemical	5
5	Pharmaceutical	6
6	Paper	2
7	Electrical and electronic goods	3
8	Hardware	12
9	Machinery	1
10	Plastic goods	12
11	Auto parts	1
12	Total	405

In addition to this there are 33 large and medium industries in Panipat, 13 of these are in the textile sector.

From the survey carried out in industrial sector and hotels in Haryana, the use and requirement of hot water in the industrial sector is as follows:
Small scale industries

- Hot water requirement in 21% industrial units
- Average hot water requirement is 300 litres per day

Large and medium industries

- Hot water requirement in 22 and 24% in medium and large industries respectively
- Average hot water requirement is 2000 and20000 litres per day in medium and large industries respectively

Fuel used for generating hot water

Diesel/HSD	28% (mainly in large and medium industries)
Wood	28% (mainly in small scale units)

Electrical power 33% (mainly in hotels)

Based on this the total hot water requirement in the industrial sector in Panipat would be 101,400 litres per day[1]. The solar collector area required, if this hot water requirement is to be fulfilled by solar thermal systems, is 2028 m². The possible fuel saving and reduction in emissions are as given below as a result of using solar thermal systems to meet the hot water requirement are as given below.

	Fuel	Fuel saving (ton/annum)	Cost saving (million Rs/annum)	CO2 emission reductio (ton/annum)
1	Diesel (72%)	98	2.03 (@Rs17/lit)	305
2	Wood (28%)	390	1.17 (@Rs 3/kg)	586

Since electricity is mainly used in hotels, it is not considered in case of industries.

The approximate coast of solar thermal system to meet the hot water requirement is Rs 13.1 million. The economic viability is indicated by the simple payback period of 4 years.

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[1] As the projections are based on the survey including all types of industrial units, and the Panipat district has majority of textile units, the actual hot water requirement will be higher than this projection.